

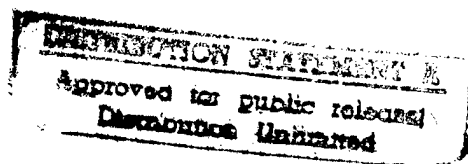
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Road to Future Testing Lies in Simulation: "Flat Trac" Provides Accuracy, Control, Reduced Costs

Engineers at the U.S. Army Aberdeen Test Center (ATC) currently are planning to adopt and expand upon a vehicle simulation concept used in the automotive industry. This effort will further enhance the ATC standing as a leader in the automotive testing arena.

Greg A. Schultz, chief of ATC's Instrumentation Applications Branch, says that ATC is studying the innovative design of MTS Systems Corporation, a Minnesota-based engineering firm. MTS engineers are pioneers in development of "hardware-in-the-loop" simulations for commercial automobiles.

MTS uses the "Flat Trac-R" Roadway Simulator (figure 1), a technology which may enable testing of the largest military trucks, allowing many of the tests performed on the proving ground test tracks to be performed under the controlled conditions of the laboratory.

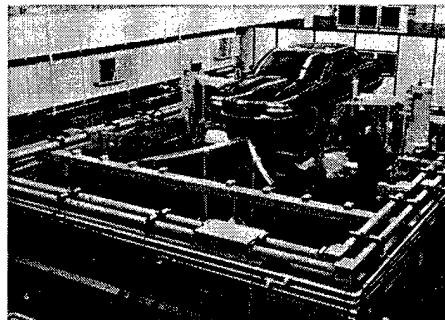


Figure 1. Flat Trac-R Roadway Simulator

ATC plans a companion project, applying the same concept for "on-the-move" testing of tank fire control systems. The proposed enhancement will be applied to the Moving Target Simulator (the "Bubble"), adding the dimension of a moving vehicle.

ATC is the Department of Defense leader for testing and evaluating land vehicles under Reliance, an interservice program for sharing technology. Two of ATC's primary missions are automotive performance testing of military trucks and combat vehicles and hit-probability testing of combat-vehicle weapon systems, such as the M1A2 Abrams tank. The center performs a wide range of accurate, cost effective, and safe automotive

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tests, assisting developers during early design and providing required data for materiel release of military vehicles.

More sophisticated, dynamic vehicles have required ATC to re-engineer its automotive test methodologies. The new technology offered by these hardware-in-the-loop simulations will provide cost effective testing in both the automotive and hit-probability missions.

Roadway simulation in the commercial sector is a powerful tool for the development and testing of passenger cars and light trucks. You have probably seen some of the ads on television touting how rugged a new pickup truck is, showing the truck mounted on a large test fixture. The "flat trac-R" simulator is such a fixture. By adaptively constraining a vehicle about its center of gravity and passing a simulated dynamic road surface beneath the vehicle, test engineers and developers simulate automotive performance tests typically conducted on open roadways. Equipment available and currently operating in industry can accommodate vehicles with engines of up to 400 horsepower, speeds up to 155 mph, and weights up to 5,500 pounds.

The ATC program will extend the technology to the heaviest military truck platforms. Benefits include ultimate control of the vehicle and control of the environment and other parameters, with significant improvements in data quality. When applied to the military testing situation, added benefits include influence of early design, extended test envelopes, extended analysis opportunities, reduced test costs, and repeatability.

Repeatability of testing conditions has long been a prime tester concern. With the emerging roadway simulator technology, ATC can simulate a nearly infinite array of test course profiles on a single machine, with tremendous repeatability and control. In addition to the desired terrain, the simulator reacts to driver inputs such as steer angle, throttle, and braking, to dynamically adjust inertial forces at each of the roadway interfaces, resulting in correct roll, pitch, and yaw angles of the vehicle. This translates to proper roadway velocity and direction, tire slip angle, torque transfer, suspension loading, and drivetrain loading during roadway maneuvers. Driver inputs can be controlled robotically for precision and repeatability or through human interface.

In addition to the simulator, ATC, in concert with developer program managers, has a requirement to extend the utility of its Moving Target Simulator facility. This facility has been effectively used for several years to test the fire control performance of "stationary" combat vehicles (such as the M1A2 tank) while engaging evasive threat targets. Simulated firings are conducted and scored based on dynamic gun line-of-sight errors and variations in ammunition and armament performance against stationary targets.

Although the Moving Target Simulator is an excellent tool, it is limited to stationary test vehicle engagements. Currently, moving vehicle fire control testing must be conducted at the live-fire ranges. In addition to being expensive, live-fire testing of moving vehicles requires precise dynamic measurement of the position of the main gun centers of rotation relative to the target. This is necessary to correct parallax errors in the test data incurred because of the changes in relative position between the vehicle and the target.

Presently, global positioning system and optical technologies do not provide the precise resolution (on the order of 0.05 mils) desired by the system evaluators. Augmentation of the Moving Target Simulator with roadway simulator technology would allow precise control and measurement capability, eventually leading to improved hit-probability performance. ATC plans to follow a rigorous development and demonstration schedule to get both of these new simulations "online" at Aberdeen Proving Ground as soon as possible. ATC's objectives are as follows:

1. Demonstrate that the horsepower and energy requirements of single and multi-axle truck platforms (5,500- to 80,000-pound gross vehicle weight (GVW)) and combat vehicle platforms (to 70-ton GVW) can be accommodated by extension of commercial automotive roadway simulator technology. Advanced control-system modeling and actual test fixtures will be used to support this demonstration.

2. Develop and demonstrate the automotive and fire control testing utility of a heavy-duty roadway simulator by focusing on the many performance tests that can be conducted using this technology. A scaled test fixture will be developed to demonstrate that the roadway simulator can realistically simulate the downhill braking tests conducted on mountain roads. Advanced control system modeling will support this part of the demonstration.

3. Demonstrate adequate fidelity achieved with the adaptive control theory technology. Use high-speed iterative techniques to converge the actual forcing function inputs to the desired forcing function inputs. Advanced control-system modeling and hardware demonstrations will show that vehicles under test and their components will experience forcing functions sufficiently representative of those experienced during actual roadway testing.

These initiatives, to bring the most advanced testing techniques from commercial industry to the military test center, are in keeping with Department of Defense policy for technology sharing. They also illustrate ATC's continuing leadership as a military tester.

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Information for this article was furnished by Greg A. Schultz, Chief, ATC's Instrumentation Applications Branch. Mr. Schultz is a 1986 mechanical engineering graduate of the University of Maryland, and is currently pursuing a master's degree.